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SPECIFICATION

1. Title of the Invention

~~Liquid crystal display panel and method of manufacturing liquid crystal display~~ substrate

2. Claims

(1) A liquid crystal display panel comprising, as a constituting element of one substrate, a liquid crystal display substrate in which liquid crystal driving foil-shape circuits are attached to a transparent support via a resin layer.

(2) A liquid crystal display panel comprising, as a constituting element of one substrate, a liquid crystal display substrate in which at least a plurality of liquid crystal driving foil-shape circuits are arranged to be attached in a planar manner to a transparent support via a resin layer.

(3) A liquid crystal display panel according to claim 1 or 2, wherein the resin layer comprises color filters.

(4) A liquid crystal display panel according to claim 1, 2 or 3, wherein the liquid crystal driving foil-shape circuits are made of liquid crystal driving thin film circuits comprising a transparent insulator thin film and thin film transistors formed thereon, and the liquid crystal display substrate has a configuration in which at least a transparent support, a resin layer, a transparent insulator thin film, and the liquid crystal driving thin film circuits including thin film transistors are stacked in this order

(5) A liquid crystal display panel according to claim 1, 2 or 3, wherein the liquid crystal

driving foil-shape circuits are made of liquid crystal driving thin film circuits comprising a transparent insulator thin film and thin film transistors formed thereon, and the liquid crystal display substrate has a configuration in which at least a transparent support, a resin layer, the liquid crystal driving thin film circuits including thin film transistors, and a transparent insulator thin film are stacked in this order

(6) A liquid crystal display panel according to claim 1, 2 or 3, wherein the liquid crystal display foil-shape circuits are made of single crystal silicon partially provided with transparent windows, and the liquid crystal display substrate has a configuration in which a transparent support, a resin layer, and the foil-shape single crystal silicon are stacked in this order.

(7) A method of manufacturing a liquid crystal display substrate, comprising: providing liquid crystal driving thin film circuits comprising thin film transistors on a transparent insulator thin film provided on a corrosive base material; attaching a transparent support onto the liquid crystal driving thin film circuits with adhesive resin for a reinforcement purpose; and removing the corrosive base material by etching.

(8) A method of manufacturing a liquid crystal display substrate, comprising: providing liquid crystal driving thin film circuits comprising thin film transistors on a transparent insulator thin film provided on a corrosive base material; attaching a transparent support onto the liquid crystal driving thin film circuits with adhesive resin for a reinforcement purpose; removing the corrosive base material by etching; and thereafter, opening contact windows in the insulator film to form transparent electrodes.

(9) A method of manufacturing a liquid crystal display substrate, comprising: providing liquid crystal driving thin film circuits comprising thin film transistors on a transparent insulator thin film provided on a corrosive base material; attaching a temporary reinforcing material to the liquid crystal driving thin film circuits with adhesive resin for a reinforcement purpose; removing the corrosive base material by etching; attaching a transparent support to a portion from which the corrosive base material has been removed; and removing the temporary reinforcing material to form a substrate.

(10) A method of manufacturing a liquid crystal display substrate, comprising: attaching a temporary reinforcing material to a surface of a single crystal silicon substrate with driving

circuits formed thereon for a reinforcement purpose; grinding the single crystal silicon from a back side so as to make the silicon substrate thinner; opening windows in the silicon substrate by partial etching; attaching a transparent substrate thereto; and removing the temporary reinforcing material to form a substrate.

3. Detailed Description of the Invention

[Field of the Industrial Application]

The present invention relates to a liquid crystal display panel. In particular, the present invention relates to a liquid crystal display substrate used in the liquid crystal display panel, and a method of manufacturing the liquid crystal display substrate.

[Prior Art]

Recently, a liquid crystal display technique has advanced remarkably, and a liquid crystal display is becoming comparable to a conventional cathode-ray tube in terms of the sharpness of an image. In addition, due to the thinness and light-weight, a liquid crystal display is occupying a place of an expected display apparatus.

A conventional liquid crystal display apparatus panel has a configuration in which two glass substrates with transparent electrodes are opposed to each other with liquid crystal disposed therebetween and attached thereto. A panel in which transparent electrodes are formed in a stripe shape and opposed electrodes are arranged so as to cross one another is called a simple matrix panel. A panel in which a thin film transistor is formed for each pixel electrode is called a TFT (thin film transistor) panel. The simple matrix panel has a simple configuration, and is less expensive with a small number of drivers. However, the simple matrix panel is significantly inferior to the TFT panel in terms of image quality. The TFT panel has satisfactory image quality; however, a transistor must be provided for each pixel electrode by using a thin film apparatus. This results in a very expensive panel with poor production yield.

[Problems to be solved by the Invention]

As described above, because of the configuration and manufacturing method, there

is a constraint to a conventional liquid crystal panel in terms of a price.

The present invention realizes a decrease in price, and does not enable a large screen (e.g., 50-inch), which was impossible in a conventional panel configuration and manufacturing method, to be manufactured.

[Means for solving the Problems]

In order to solve the above-mentioned problems, according to the present invention, a liquid crystal display substrate with a liquid crystal display foil-shape circuit attached to a transparent support via a resin layer is used as a constituting element of one substrate of a liquid crystal panel.

[Function]

The present invention can increase the yield of a panel and easily realize a large screen. Furthermore, the present invention enables satisfactory image quality to be obtained.

[Example]

Hereinafter, the configuration of a liquid crystal display substrate used in a liquid crystal display panel of the present invention will be described by way of an example with reference to the drawings.

FIG. 1 is a cross-sectional view showing an example of a liquid crystal display substrate used in a liquid crystal display panel of the present invention. A generally well-known liquid crystal display panel using TN liquid crystal is configured by opposing a substrate and a counter electrode to each other with a gap therebetween, injecting liquid crystal therebetween, and disposing polarizing plates on an outside.

Alignment treatment is performed generally under the condition that a liquid crystal molecule alignment layer is provided on each surface of the substrate and the counter electrode in contact with the liquid crystal. According to the present invention, it is important that one of the substrates of a liquid crystal display panel has a configuration as shown in FIG. 1. This substrate may be variously treated or may be provided with

another element. In the following, only a basic configuration will be described. Reference numeral 101 denotes liquid crystal driving foil shape circuits composed of a liquid crystal driving thin film circuit, formed on a transparent insulator thin film 108. In the figure, the thin film circuit is shown in a simply omitted manner. Reference numeral 104 denotes a gate electrode, 105 denotes a semiconductor thin film, 106 denotes a source or a drain, which constitute a thin film transistor. Reference numeral 107 denotes a transparent electrode. Actually, various additional films are to be included. These films are not important for the main points of the present invention, so that they are omitted. As a liquid driving crystal thin film circuit, those which use an amorphous silicon thin film and those which use a polysilicon thin film are used at present. As a thin film element that is not active, there is a non-linear element using an anodic oxide film of titanium.

Reference numeral 103 denotes a transparent support, and 102 denotes a resin layer for attaching the transparent substrate to the liquid crystal driving foil-shape circuit.

Because of the configuration as shown in FIG. 1, a number of advantages are obtained. As described later, a first advantage is that a plurality of liquid crystal driving foil-shape circuits are arranged to be connected in a planar manner on one transparent support to provide a seamless image. A second advantage is that when liquid crystal driving foil-shape circuits are formed, its substrate may not be transparent, and a high-temperature process, enabling transistors with good characteristics to be obtained, can be used (as described later, in a process of forming liquid crystal driving foil-shape circuits, a substrate to be removed later for forming liquid crystal driving foil circuits is not required to have transparency, and an inexpensive heat-resistant substrate can be used). In particular, this is effective for manufacturing liquid crystal driving thin film circuits of polysilicon. A third advantage is that a light resin can be used for a transparent support, which is advantageous for a large screen.

FIG. 2 is a view showing the processes illustrating one method of manufacturing the liquid crystal display substrate shown in FIG. 1. FIG. 2(a) shows the liquid crystal driving foil-shape circuits 101 including thin film transistors 201 formed on the transparent insulator thin film 108 on a corrosive substrate 202. The corrosive substrate 202 is, for example, a silicon wafer. As the transparent insulator thin film, there is a silicon oxide

film formed on a silicon wafer.

The above-mentioned things are commercially available. The liquid crystal driving thin film circuits including thin film transistors can be formed by using an amorphous silicon thin film or a polysilicon thin film.

FIG. 2(b) shows that a transparent support 203 made of glass, plastic or the like is attached, with a resin layer 204, onto the liquid crystal driving foil-shape circuits with the corrosive substrate thus formed.

FIG. 2(c) shows a liquid crystal display substrate 205 obtained after the corrosive substrate 202 is removed by etching.

In the case where the corrosive substrate 202 is made of silicon, and the transparent insulator thin film 108 is made of silicon oxide, the above-mentioned configuration can be easily realized by chemical etching, using the transparent insulator thin film 108 as a stopper. This is will-known to those skilled in the art familiar with a semiconductor process. It is also easily considered that the corrosive substrate is made of metal.

FIGs. 3 and 4 show other examples. In the case where driving is performed under the condition that liquid crystal is interposed between the liquid crystal display substrate 205 and the counter electrode, when the transparent insulator thin film 108 is thick, a high driving voltage is required. In such a case, it is possible to form a dent 301 only in a portion corresponding to a pixel electrode as shown in FIG. 3. Alternatively, it is also possible that a contact window 401 is opened in the transparent insulator thin film to form a transparent electrode 402, as shown in FIG. 4. In this case, the transparent electrode 107 shown in FIG. 1 is not required. This does not deviate from the present invention. The configuration shown in FIG. 4 is obtained only by opening a contact window in the transparent insulator thin film after the state in FIG. 2(c) in the process of FIG. 2, thereby forming a transparent electrode.

Depending upon the liquid crystal to be used, an alignment film is provided on the transparent insulator thin film 108 on the liquid crystal display substrate 205, and an alignment treatment is performed. This is not out of the scope of the present invention either.

FIG. 5 shows a cross-sectional view showing another example of the liquid crystal display substrate used in the liquid crystal display panel of the present invention. A resin layer is configured so as to include color filters. Each color RGB 502, 503, 504, and black 501 of the color filter are buried in the resin layer 102. A resin layer for adhesion may be present between the transparent support 103 and the color filter layer.

FIG. 6 shows another configuration of a liquid crystal display substrate. In this configuration, a plurality of liquid crystal driving foil-shape circuits are arranged in a planar manner, instead of one liquid crystal driving foil-shape circuit, and the circuits are held by one transparent support. Therefore, irrespective of the size of one liquid crystal driving foil-shape circuit, a liquid crystal display substrate with a large size can be formed. Even if there is a connecting portion, the thickness of the connecting portion is small, so that the connecting portion is not visible. In the figure, the liquid crystal driving foil-shape circuit is interrupted by a connecting portion 601. The thin film transistors 201 are omitted. One liquid crystal driving foil-shape circuit and an adjacent liquid crystal driving foil-shape circuit are connected to each other through the contact window 602 by a connecting line 603 (gate electrode or source electrode). As described later, the connection can also be performed on a surface of the transparent insulator 108 where the thin film transistors are present.

According to the method of manufacturing a liquid crystal display substrates in FIG. 6 using a plurality of liquid crystal driving foil-shape circuits, it is only required to prepare a plurality of corrosive substrates and arrange and adhere them on one transparent support. The process thereof is the same as that shown in FIG. 2. After removing the corrosive substrates, it is only required to open contact windows and perform wiring.

FIG. 7 shows another cross-sectional view of the liquid crystal display substrate used in the liquid crystal display panel of the present invention. In this figure, the liquid crystal driving foil-shape circuits are placed upside down compared with those shown in FIG. 1. The side of the transparent insulator thin film 108 adheres to the transparent support 103 with the resin layer 102.

FIG. 8 shows the processes illustrating the method of forming the liquid crystal display substrate having the configuration shown in FIG. 7. In FIG. 8(a), the transparent

insulator thin film 108 and the liquid crystal display driving foil-shape circuits 101 made of liquid crystal driving thin film circuits are formed on the corrosive substrate 202 in this order by the same process as that shown in FIG. 2(a). Reference numeral 201 denotes thin film transistors. In the process shown in FIG. 8(b), a temporary reinforcing material 801 is attached to the liquid crystal driving foil-shape circuits with removable resin 802(e.g., thermoplastic resin such as wax, resin soluble in a solvent, or the like) disposed therebetween. Then, as shown in FIG. 8(c), the corrosive substrate 202 is removed by etching. The processes up to here are the same as those in FIG.2, except for the removable resin and the temporary reinforcing material. After the corrosive substrate is removed, a transparent support 803 is attached with a resin layer 804, as shown in FIG. 8(d). Thereafter, as shown in FIG. 8(e), the temporary reinforcing material 801 is removed together with the removable resin, whereby a liquid crystal driving substrate is competed.

FIG. 9 shows a cross-sectional view of another example of the liquid crystal display substrate used in the liquid crystal display panel of the present invention. This liquid crystal display substrate is obtained by attaching liquid crystal driving foil-shape circuits 901, in which windows are opened in foil-shape single crystal silicon, to a transparent support 902 via a resin layer 903. Reference numeral 907 denotes a single crystal silicon and 905 denotes transistors. Reference numeral 904 denotes a transparent insulator thin film made of silicon nitride or silicon oxide. Reference numeral 906 denotes a transparent electrode.

FIG. 10 shows the processes illustrating the method of forming the liquid crystal display substrate having the configuration shown in FIG. 9. FIG. 10(a) shows a silicon wafer on which liquid crystal driving circuits including transistors are formed. Circuits 905 are present on the surface of the silicon wafer 907, and an oxide film or nitride film 904 is formed on the circuits 905. Contact windows are opened in this configuration, whereby the transparent electrodes 960 formed thereon are connected to the circuits 905. The circuits 905 are schematically shown. A temporary reinforcing material 1001 is attached to the silicon wafer with a removable adhesive 1002 (e.g., wax), as shown in FIG. 10(b). The silicon wafer generally has a size of 400 to 700 μm. Therefore, it is difficult

to form holes (about 30 $\mu\square$) corresponding to pixels of the liquid crystal display panel. Etching with a large aspect ratio by special plasma etching (ECR) is possible, which does not satisfy the current needs. It may be possible in the future. Mechanical grinding is performed on the silicon wafer up to a thickness of 50 μm. Such a technique has advanced remarkably, which is extensively used for manufacturing a discrete FET. Transparent windows 1003 are opened by liquid photolithography, as shown in FIG. 10(c). Then, the transparent support 902 is attached using the resin layer 903 as an adhesive, as shown in FIG. 10(d). Then, the temporary reinforcing material is removed to obtain a liquid crystal display substrate as shown in FIG. 10(e). In the case where the adhesive 1002 is wax, the temporary reinforcing material can be easily removed by melting the adhesive 1002 by heating.

[Effect of the Invention]

As is apparent from the above, according to the present invention, an array of driving circuits with good yield and a small size is transferred to a transparent support. Therefore, a liquid crystal display substrate can be manufactured with good yield. Furthermore, an ultra-large liquid crystal display substrate can also be manufactured.

4. Brief Description of the Drawings

FIG. 1 is a cross-sectional view of a liquid crystal display substrate used in a liquid crystal display panel in one example according to the present invention. FIG. 2 shows the processes illustrating one method of manufacturing the liquid crystal display device in FIG. 1. FIGs. 3 to 7 are cross-sectional views of a liquid crystal display substrate used in a liquid crystal display panel in other examples according to the present invention. FIG. 8 shows the processes illustrating a method of manufacturing the liquid crystal display substrate having the configuration shown in FIG. 7. FIG. 9 is a cross-sectional view showing another example of a liquid crystal display substrate used in a liquid crystal display panel of the present invention. FIG. 10 shows the processes illustrating a method of manufacturing the liquid crystal display substrate having the configuration shown in FIG. 7.

101, 901: LIQUID CRSYTAL DRIVING FOIL-SHAPE CIRCUIT

102, 204, 804, 903: RESIN LAYER

103, 203, 803, 902: TRANSPARENT SUPPORT

104: GATE ELECTRODE

105: SEMICONDUCTOR THIN FILM

106: SOURCE OR DRAIN

107, 906: TRANSPARENT ELECTRODE

108, 904: TRANSPARENT INSULATOR THIN FILM

201: THIN FILM TRANSISTOR

~~202: CORROSIVE SUBSTRATE~~

205: LIQUID CRYSTAL DISPLAY SUBSTRATE

301: DENT

401, 602: CONTACT WINDOW

501: BLACK

502: R (red)

503: G (green)

504: B (blue)

601: CONNECTING PORTION

603: CONNECTING LINE

801, 1001: TEMPORARY REINFORCING MATERIAL

802, 1002: REMOVABLE RESIN

905: TRANSISTOR

907: SINGLE CRYSTAL SILICON WAFER

1003: WINDOW

FIG. 1

101: LIQUID CRSYTAL DRIVING FOIL-SHAPE CIRCUIT

102: RESIN LAYER

103: TRANSPARENT SUPPORT

104: GATE ELECTRODE

105: SEMICONDUCTOR THIN FILM

106: SOURCE OR DRAIN

107: TRANSPARENT ELECTRODE

108: TRANSPARENT INSULATOR THIN FILM